Space Weather Technical Forecast

Issued on Saturday, 23 July 2022 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Earth-directed CME expected 23 July. G1/Minor Storms expected with G2/Moderate storms likely and slight chance of G3/Strong Storm. Slight chance of M-flares (R1-R2 Radio blackouts) throughout. Chance of Active electron fluence by Day 4 (25 July).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low over the last 24 hours, with only modest C-class flare activity. There are seven sunspot regions on the visible disc, but none of these evolved significantly in appearance or magnetic complexity. In addition to the forecast CME, two further CMEs have been observed leaving the western side of the Sun and will be analysed when further imagery becomes available, for a potential Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1 as steadily increased from slightly elevated to elevated levels, reaching 550km/s by the end of the period, as the Earth connected with a coronal hole high speed stream. Density has been around or just above average. Total magnetic field strength started moderate, around 12nT, but has steadily declined to weak levels. Bz started varying moderately, due to the onset of the high speed stream, but has since only varied weakly. Phi angle has been resolutely negative (towards the Sun). Geomagnetic activity started Active, with one interval between 0000-0300UTC, but has otherwise been Quiet to Unsettled.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at background levels. High energy electron flux started at background levels, recovering to moderate levels, approaching but not exceeding the high threshold. Electron fluence has been below the Active threshold throughout with a flat trend. Fluence reached 2.47e7 integrated pfu at 23/0000 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Activity is expected to remain mainly Low, with a slight chance of Moderate activity from a number of currently inert regions on the visible disc.

Solar Wind / Geomagnetic Activity: A full halo CME which left the Sun on 21 July is due to arrive at Earth on 23 July, with the effects of the feature likely to continue through much of the period. Otherwise a coronal hole high speed stream is expected to affect the Earth through days 1 and 2 (23 and 24 July), with the effects of this likely to decline on day 3. Geomagnetic activity is expected to be Unsettled, with some Active intervals possible at first, but with a risk of G1/Minor Storms or G2/Moderate Storms due to the onset of the CME. There is also a very slight chance of a G3/Strong Storm. A gradual decline in activity is then expected through days 2 and 3, but with some enhancements possible in any sustained periods of negative Bz.

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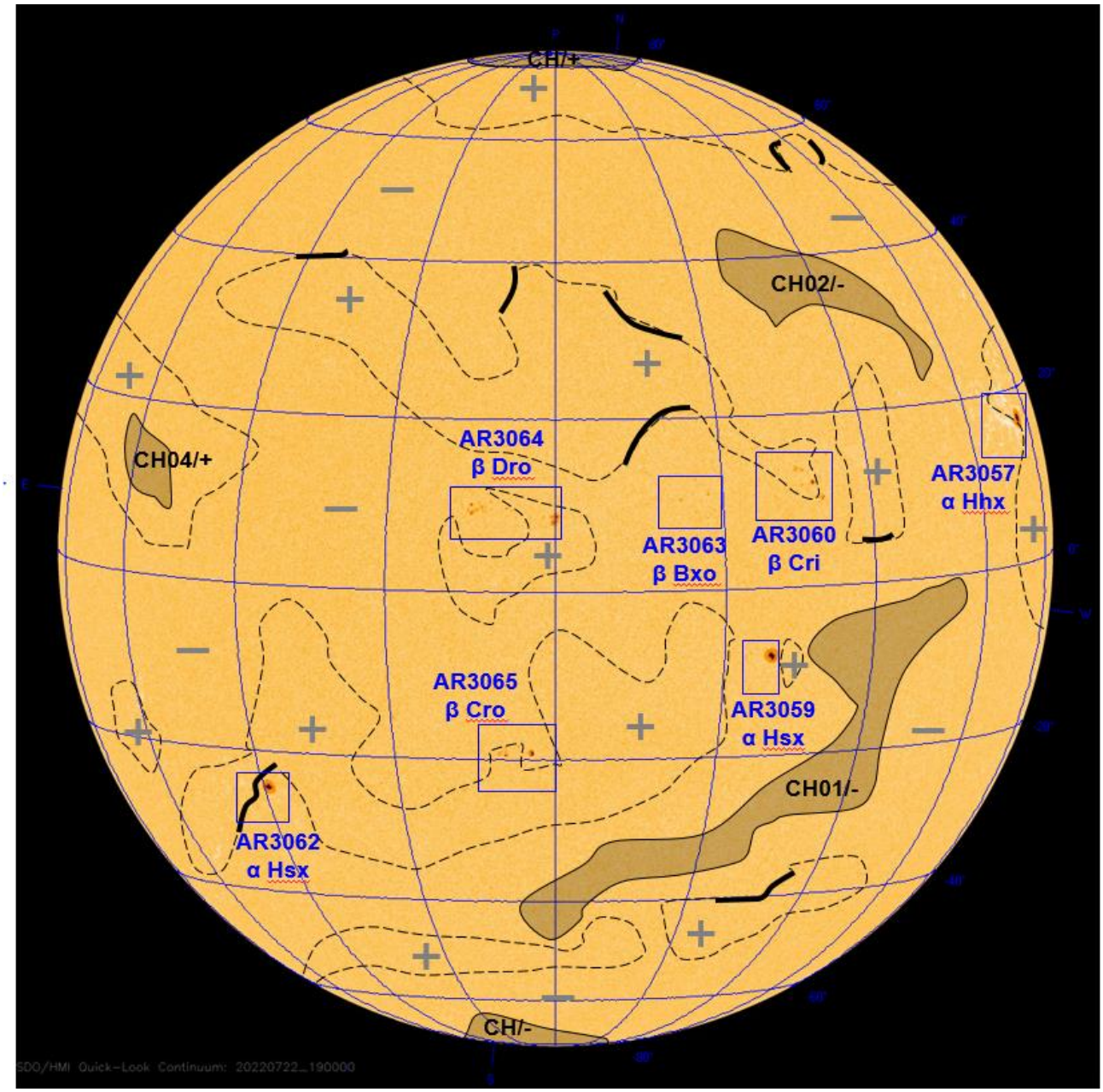
Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is most likely to remain at background levels. The high energy electron flux (greater than 2 MeV) is expected to be at background to moderate levels on days 1 and 2 (23 and 24 July) then increase perhaps to high levels at the diurnal peaks on days 2 and 3 (24 and 25 July) as CME effects wane. The associated fluence is expected to rise, with a chance of reaching the Active threshold (1e8 integrated pfu) on day 4.

Figure 1. Solar Analysis Valid 22/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A full halo CME which left the Sun on 21 July is expected to reach the Earth on 23 July, giving a risk of G1/Minor or G2/Moderate Storms. Enlil ensemble models suggest a tight cluster of potential arrival times, giving a higher than normal confidence of a direct hit early on 23 July. Otherwise, the Earth is currently under the influence of the high speed stream from a combination of coronal holes 01 and 02. The effects of the high speed stream are expected to continue through day 1 and day 2 (23 and 24 July, before declining through days 3 and 4.

Geomagnetic activity is expected to be Unsettled, with some Active intervals possible at first, but with a risk of G1/Minor Storms or G2/Moderate Storms due to the onset of the CME. There is also a very slight chance of a G3/Strong Storm. A gradual decline in activity is then expected through days 2 and 3, but with some enhancements possible in any sustained periods of negative Bz.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	20	5	1
Strong	G3	No	10	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
21/0409	Full	Filament eruption	12N 02E	900-950km/s	23/0300UTC	G1/G2 storms likely.

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Figure 2: MOSWOC Enlil model showing potential arrival time.

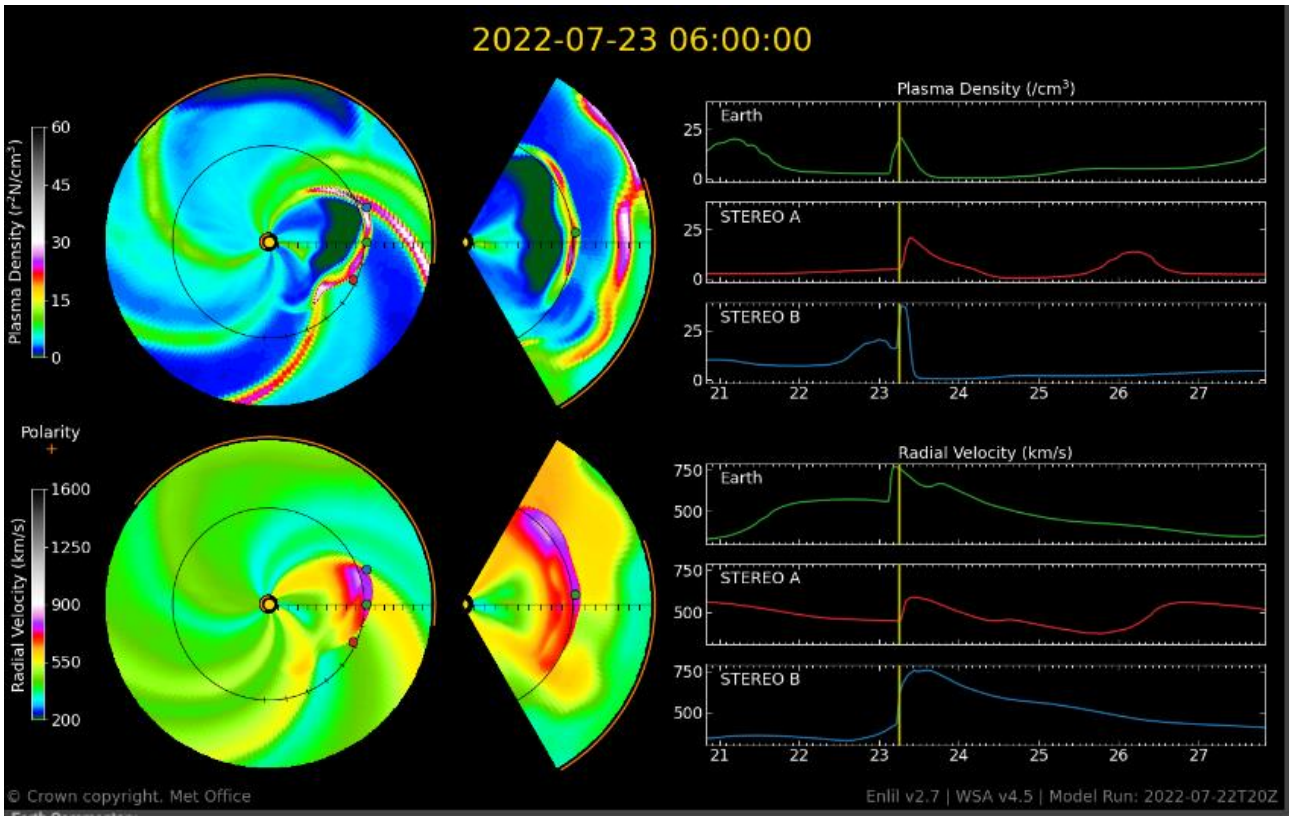
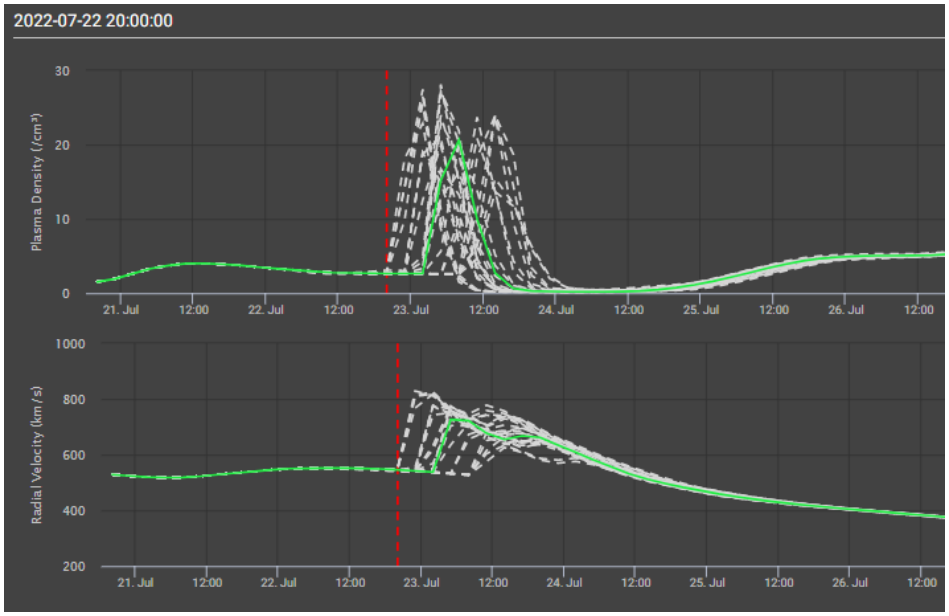


Figure 3: MOSWOC Enlil ensemble, showing tight cluster of potential arrival times.



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Met Office Space Weather Technical Forecast

Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the last 24 hours, with only one significant C-class flare. There are seven sunspot regions on the visible disc, but these are showing only modest evolution and limited complexity. There is a bright flux region just beyond the eastern limb, which may rotate onto the disc in the next 24 hours.

Solar activity is expected to remain Low, with a slight chance of Moderate activity.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels. As most regions are small and relatively magnetically simple, the risk of a proton enhancement is very low.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
The high energy electron flux is expected to follow a generally increasing trend on diurnal highs throughout the period, but is likely to be suppressed on day 1 (23 July) due to the effects of an anticipated full halo CME arrival. Once the effects of the CME dissipate, the rising trend is expected to become re-established from day 2 (24 July), with an increasing chance of persistent levels above the high (1000pfu) threshold.

Electron fluence is expected to remain below the Active (1e8 integrated pfu) level in day 1, but with a rising trend from day 2 in line with increasing flux levels, as CME effects wane. There is then an increasing risk of reaching the Active threshold as the period progresses.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	20	30	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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